SYSTEM AND METHOD FOR MEASURING THE TRANSFER DURATIONS AND LOSS RATES IN HIGH VOLUME TELECOMMUNICATION NETWORKS

BACKGROUND OF THE INVENTION

The present invention relates to a non-intrusive method for measuring the loss rates and transfer durations for data in a telecommunication network in packet mode.

The invention is particularly adapted to high volume networks that are operated in non-connected mode. It relates also to a *distributed architecture* system comprising a plurality of flow observation probes arranged in several points in the network, and means for transmitting these measurements to a collecting module which is connected to storage means and means for analyzing the measurements that have been provided.

Packet mode telecommunication networks are characterized in that transmitted information are conveyed in groups referred to as packets, that are substantially made up of one header which contains information for sending a packet through the network as well as data to be transmitted. Such packets are conveyed through the network, and travel, in accordance to what suits the best the latter, through the most diversified transmitting and switching means.

An exemplary packet mode network is the Internet network which is operated with IP protocol (Internet Protocol). As a few examples of transmitting and switching means related to the IP protocol, ISDN (integrated services digital network), FR (Frame Relay), ATM (Asynchronous Transfer Mode), SDH (Synchronous Digital Hierarchy), SONET

(Synchronous Optical network), DWDM (Dense Wavelength Digital Multiplexing) networks, etc., can be found.

close with one another.

The present invention aims to alleviate the above-mentioned drawbacks.

SUMMARY OF THE INVENTION

To this end, one object of the invention is to provide a method and a system with a distributed architecture that allow to measure accurately the transfer durations and loss rates for telecommunication networks in packet mode. The method comprises the steps for performing the measurement operations by a plurality of observing probes that are synchronized and distributed at different points in the network, on data packets which are transmitted through the network, the measurement operations comprising the dating and the identification of the data packets, the measurement results being transmitted from the probes to the collecting module.

The method according to the invention is characterized in that the measurement operations further comprise a classification of the data packets in a homogenous flow, and a counting of the packets in the flow, the measurement results being transmitted from the probes to the collecting module through the network (1), the collecting module performing a correlation between all of the measurement results received from the probes, including the determination of the unidirectional transfer durations per flow or information flow group, and of the loss rate for the packets.

The method according to the invention is advantageous in that it does not require the use of test packets, which permits the achievement of a very wide representativeness of every measurement. It is also advantageous in that a

large number of measurements can be carried out, resulting in a high degree of statistical accuracy. Finally, the number of measurements being carried out can be modulated in

in one flow, the transmitting means of the probes using the network to transmit the measurements carried out to the collecting module, the collecting module comprising means for determining the unidirectional transfer durations per flow or information flow group and the loss rate for the packets.

BRIEF DESCRIPTION OF THE DRAWINGS

Other characteristics and advantages of the invention will be more fully understood from the following description to be considered as a non-limitative example while referring to the appended drawings, in which:

Figure 1 shows schematically an exemplary embodiment of the invention in a telecommunication network in packet mode;

Figure 2 shows a functional diagram of a system implementing a method according to the invention;

Figure 3 depicts schematically an example of an internal function organization for a system according to the invention;

Figure 4 shows a functional diagram depicting the operation of an observing probe used in a system according to the invention;

Figure 5 shows a functional diagram depicting the operation of a collecting module used in a system according to the invention; and

Figure 6 to 15 depict schematically the operation of a system according to the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

In Fig. 1, there is shown schematically a high volume network 1 that is operated in non-connected mode, such as a

network based on IP protocol (Internet Protocol). A plurality of flow-observing probes 2_i are arranged at different points in the network for carrying out measurements on flows of data that are exchanged through this network. Means for compressing

each packet they have access to. These measurements consist in performing dating, classification and identification of the packets, as well as compressing these measurements. Every probe 2_i transmits, through the network 1, the compressed measurements to the collecting module 4 that correlates all of these measurements.

Other embodiments are also possible in the scope of the invention, notably in the following cases:

- the users 8_i are not necessarily end users for information being conveyed within the packets; for instance, they may represent local networks or other networks in packet mode;
- the probes 2_i can be connected to the collecting module 4 through means other than the network 1; for instance, through another telecommunication network, or through a local storage medium that stores data from the collecting module 4, sending them back to it later on;
- the same collecting module 4 can be connected to several collecting modules 4;
- several collecting modules 4 can communicate to build up correlations between measurement elements they have.

As an example, a possible functional diagram of the system according to the invention is shown in Fig. 3. Four functional groups can be found therein:

- the rule group 10, with the rules being fixed statically or semi-statically (for example by the system operator);
- the load evaluation group 20, measuring the load rate on the local central processing unit, the memory occupancy, etc...;
- the calculation group 30, evaluating dynamically the values relating to compaction, sampling, etc...;

- the data path group 40, producing records that contain combinations (class, date, signature) for each packet.

When activated, the probes 2_i gain a common time reference 31. The inaccuracy of this reference between two probes 2_i affects directly the accuracy of the result for the whole device. Means for gaining that time reference can be diversified as well as multiple; as non-limitative examples, GPS (Global Positioning System), broadcasting through radio waves, high stability drivers, NTP (Network Time Protocol) and SNTP (Simple Network Time Protocol) protocols may be mentioned;

- each packet is subjected to dating 41 using the absolute time reference when it is observed by a probe 2_i. The latter is able to date, either the start of the packet, or the end of the packet, or any other criterion.
- each packet is subjected to the calculation of the signature 42, that is for representing it later on. The signature enables to reduce the amount of information which is needed to identify the packet. That signature results typically from a binary polynomial calculation (for instance, CRC calculation - cyclic redundancy check - on 16 or 32 bit elements). The signature calculation is performed either on the whole packet or on a part of it, in accordance to what is contemplated in relation with the structure and the variability of the contents of the packets in the network. The signature has to be small compared to the mean pocket size, so as to ease its storage, its transmission and its subsequent processing. It must be capable of assuming different values to make negligible the likelihood that two different packets have the same signature. As an example, it

can be considered that one signature on 16 bit elements enables to identify about 256 different packets with a low likelihood of ambiguity;

- each packet is subjected to a classification operation 44. Criteria for classification are typically those that are conventionally retained to identify flows between networks and sub-networks (such as IP network sub-addresses), flows between end equipment (such as IP addresses), flows between applications (such as IP addresses and UDP/TCP transport addresses), etc... Each packet is then identified by combining all or part of the elements : class, date, signature;
- each class can be subjected to filtering 45; i.e., the probes 2_i do not store the combinations (class, date, signature) for packets belonging to one of the classes for which the filter has been provided;
- each class can be subjected to a compaction or a semi-static sampling operation 46. In this case, only a part of the combinations (class, date, signature) for packets belonging to a given class will be retained. The sampling rate depends typically of the class, and will not theoretically change dynamically. For instance, it may be desirable to keep all of the combinations of packets conveying voice, and only a part of those conveying computer files.
- each class can be subjected to a dynamic sampling with a rate which depends of the congestion conditions in the system : measurement of the occupancy of buffers 21 and memories 22 of the probes 2_i, transmission flow rates towards the collecting module 4, network load, load of the collecting module 4, etc... A multiplicity of criteria can be used so that the overall operation

can take place automatically in an area that suits the best the device administrator. For instance, the highest sampling rate for a given maximum flow rate of a flow brought back from the probe to the collector, or a minimum flow rate of a flow brought back to the collector for a given sampling rate;

- a counter is associated with each combination (class, date, signature) that is retained, indicating the number of packets observed in the flow. The collecting module 4 is then capable to measure the loss rate in the network by comparing between the counters associated with the same packets at different points in the network.

The filtering and static and dynamic sampling operations allow to reduce the amount of combinations (class, date, signature) to be stored and processed. The provision or removal of filters, the values of the semi-static sampling rates, the parameterization the dynamic sampling, etc..., can be achieved, for instance, through an administrative operation performed from one of the collecting modules 4 or operating modules 7.

Sampling criteria can be diversified. As examples, periodical sampling which consists in keeping one combination every N combinations, statistical sampling that depends on drawing a random variable of which statistical characteristics are under control, and sampling on signature that consists in keeping only those combinations of which the signatures belong to a given set of values can be mentioned.

The sequence order through which a probe 2_i performs the above-mentioned operations may change. A probe 2_i can classify the packets before dating them, as long as the measurement accuracy is not altered to a great extent. In

the same way, the filtering operations can be performed at different instants during the process.

Fig. 5 depicts the steps for collecting and correlating the measurements by a collecting module 4.

The latter receives samples of the non-filtered combinations (class, date, signature) originating from all of the observing probes 2_i attached therewith;

- each packet is theoretically seen by two observing probes 2_i : the first time when entering the network, the second time when leaving. However, other situations may occur. For instance, one packet might be seen only once if the supervision domain is not closed, or more than twice if there are observing probes 2_i within the network;
- each time a packet has been observed by an observing probe 2_i as passing by, one combination (class, date, signature) is received by the collecting module 4, except when filtering, sampling or loss of return message, etc..., is taking place;
- the collecting module 4 correlates the combinations (class, date, signature) for the same packet, for instance by comparing between the signatures and by increasing the transit delays in the network;
- in case of success, it infers from above, through a simple arithmetical calculation, on one hand, the transfer duration between the different observing probes 2_i for the packet in question and on the other hand, the number of packets that were possibly lost in the network. Moreover, a number of packets in excess at the exit enables to indicate that a fault in one of the network devices or an intrusion attempt has occurred. More sophisticated calculations, such as mean, minimum, maximum, median, etc..., values for a given time slot and a certain flow

type, can also be achieved in the collecting module 4 prior to the storage operation

It is to be noted that sampling do not reduce the counting accuracy. This is equally true when packets are lost, that otherwise would have cause tickets to be issued. Actually, the counter that is associated with every ticket produced yields the total number of packets since the last sampled ticket. The only consequence is a loss of accuracy as for the precise instant at which the loss occurred and the exact identity of the packet that was lost. Both characteristics are of little usefulness a priori, thus being not much looked after. However, as the sampling characteristics are attached to a certain flow, it is always possible not to sample the flows for which detailed information are desirable. For those flows, all of the packets will cause one ticket to be issued. Moreover, as the number of measurements is lower than the number of packets, statistical laws will be applicable, that are well known as for the validity and the accuracy of the measurements which are applied to the sample thus captured.

Therefore, the method according to the invention enables to achieve flow control at the probe level in order:

- to protect the collecting module 4 against an overload : (too many tickets to be processed relatively to its own resources that are the available processing power and the memory size,...);
- to protect the probes 2_i against an overload : (too many tickets to be processed relatively to its own resources that are the available processing power and the memory size,...);
- to protect the network used to transmit ticket records from the probe to the collector;

- to adapt to changes in the capacity of the network used to transmit ticket records from the probes 2_i to the collecting module 4;

- to enable an optimum distribution of the measurement resource between the different flows in case of congestion;
- to optimize the pair (measurement accuracy/network load) in accordance with combined criteria, in normal operation.

To control the flow, the following functions may by used, separately or in combination:

- limitation of the overall flow through the network to a maximum value due to the transmission of ticket records from the probes 2_i to the collecting module 4. That limit can, either be defined by an initial configuration, or be modulated by the collecting module 4 or by an external device operating the network;
- limitation of the sampling rate to a maximum value. That limit can, either be defined by an initial configuration, or be provided by the collecting module 4 or by an external device operating the network. In addition, it may differ from each type of flow or flow group;
- reduction of the sampling rate. That reduction can, either be defined locally by observing the congestion of the probes 2_i, or be fixed by the collecting module 4 or by an external device operating the network. That reduction may differ for each type of flow or flow group. The reduction law must allow the collection module 4 to correlate records which were performed by probes 2i 2_i having not the same sampling value for a given flow, the reduction being not necessarily synchronous between the probes 2_i. A principle which must be retained is the inclusion one; tickets of the "reduced" flows having to be included also in the tickets of the "lesser reduced" flows. In this way, tickets of the probe 2_i having the highest reduction factor